

Fig. 1. Computed radiative equilibrium surface temperature contours on the X-33 vehicle with the elevon control surface deflected 25 degrees at Mach 9, an angle of attack of 30 degrees, and an altitude of 180,000 feet.

Point of Contact: D. Kontinos
 (650) 604-4283
 dkontinos@mail.arc.nasa.gov

CFD Analysis of Arc-Jet and Flight Environments for the B-2 Flight Experiment

Mark Loomis, Grant Palmer

Ames Research Center has been developing new ultrahigh temperature ceramics (UHTC) for potential use in the sharp leading edges of future space vehicles. These materials have been developed and tested in ground-based arc-jet facilities, and a flight test program called SHARP (slender hypervelocity research aerothermodynamic research probes) has

been initiated. The first flight demonstration, SHARP-B1, incorporated a 0.141-inch-radius UHTC nose-tip on a U.S. Air Force reentry vehicle in collaboration with Sandia National Laboratory; it was successfully flown in May 1997. The second flight test, SHARP-B2, incorporates four instrumented UHTC strakes mounted on the side of the entry vehicle; it is scheduled to fly in June 2000. The goal of these flight tests is to assess the performance of the materials under realistic entry conditions.

Computational fluid dynamics (CFD) simulations of the flight environment have been performed to aid in the design of the test hardware and instrumentation, and simulations of critical qualifying ground tests in the arc-heated wind tunnels have been performed to aid in test interpretation and instrument checkout, and to show traceability of the ground-test environment to flight.

Figure 1 shows computed heat-transfer profiles on the surface of the flight vehicle and the test article in the arc-heated wind tunnel. Although simulation of the complex-flow physics in the arc-heated wind tunnel is difficult, the goal of the simulations is to understand the flow environment well enough that the similarities and differences in the flight conditions can be assessed. Initial comparisons between the CFD and arc-jet data are generally within 40% for heat transfer and 5% for pressure, giving some confidence in the predictive method. The CFD predictions will be compared with flight results once they are available.

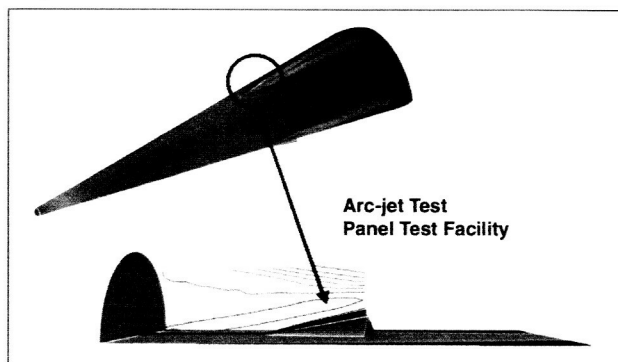


Fig. 1. Heat-transfer profiles for flight vehicle and test article. Flight: Modified MK-12 RV launched on Minuteman III.

Point of Contact: M. Loomis
 (650) 604-6578
 mloomis@mail.arc.nasa.gov